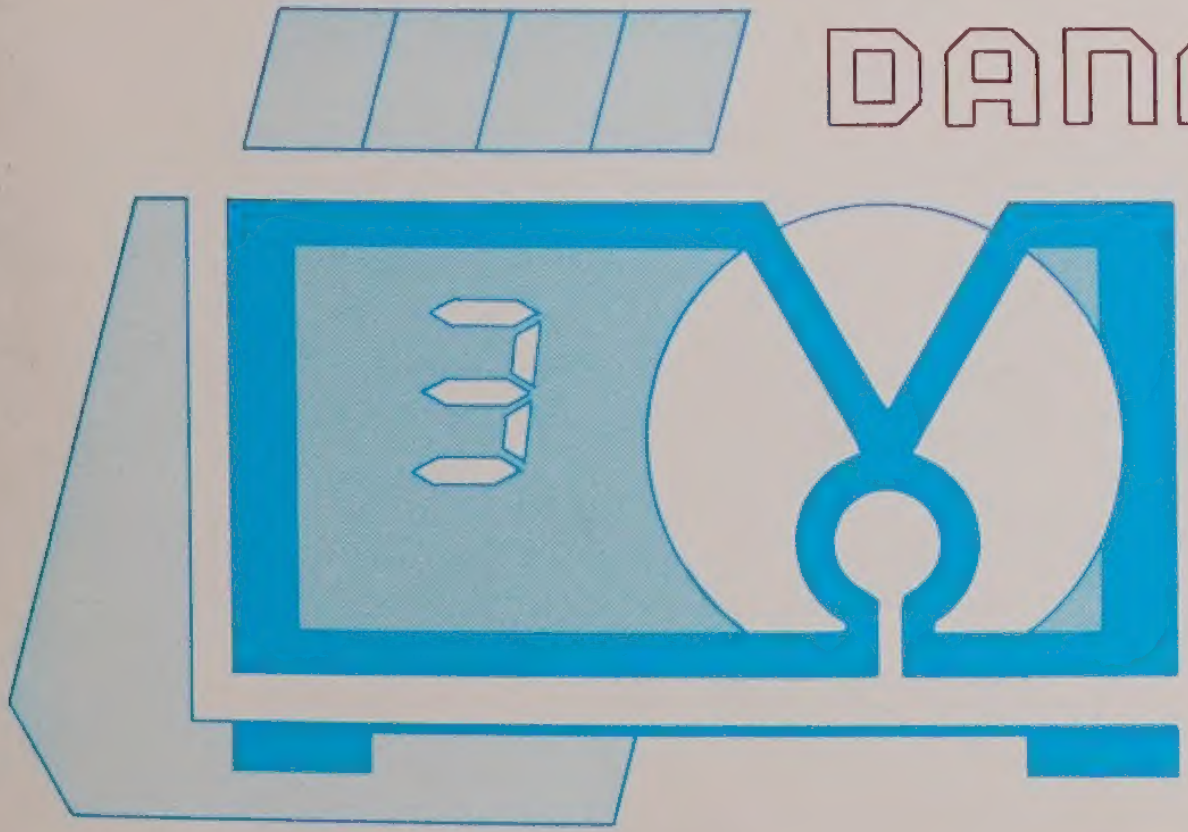
INSTRUCTION MANUAL



# DANAMETER

2000A

RACAL-DANA

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PUBLICATION NO. 980464A

# RACAL-DANA MODEL
# 2000A
# DANAMETER

PUBLICATION DATE: JANUARY 1979

## WARRANTY

Within one year of purchase, Racal-Dana Instruments will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship (battery excluded). All parts and labor charges will be paid by Racal-Dana Instruments. Contact your local Dealer in the event service is required.

## SERVICING INSTRUCTIONS

1. Before seeking assistance check that:
   a. The battery is more than 6 volts.
   b. The fuse is good and of the proper type and size.

2. Repair of this unit can be accomplished on an exchange basis or a repair and return basis. Contact your nearest sales representative for the plan that best suits your needs. Since there are several options, including a 24-hour procedure, it is important to get the proper instructions.

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# SECTION 1 GENERAL DESCRIPTION

## 1.1 GENERAL.

1.2 Your Danameter solid state volt-ohm-microamp meter is designed for the engineer, technician, and hobbyist who requires a rugged, portable, accurate, and reliable measurement tool. The Danameter is capable of performing a wide assortment of measurement functions and is equally useful on the bench or in the field. Measurement capabilities include dc volts from 1 millivolt to 1000 volts, ac volts from 1 millivolt to 700 volts RMS, resistance from .1 ohm to 199.9 megohms and dc current from 10 nanoamps to 2 amps. With accessories the capacity of the instrument is expanded to include RF voltage with frequency measurements to 200 MHz and high voltage dc measurements to 50,000 volts. Built with state-of-the-art LSI circuitry and housed in a virtually unbreakable Cycolac T case, your Danameter will provide you with years of reliable service.

## 1.3 FEATURES.

1.4 Fully Portable. Operates up to one full year on a single 9-volt (transistor radio type) dry battery. A switch position is provided to measure the battery voltage. The instrument is extremely light, weighing only 1 pound and operates at full accuracy at any angle. A handy carrying case is available.

1.5 Easy to Operate. One switch selects off on, battery test, and all functions and ranges. Input leads are never required to be moved for a special range, function, or polarity.

1.6 Digital Display. Liquid crystal readout provides large easy to read numbers and decimal placement as well as automatic polarity indication on DC volts and current measurements.

1.7 High Input Resistance. Ten megohms on all d.c.v. ranges and two megohms on all a.c.v. ranges insures higher measurement accuracy in high impedance circuits and minimizes affecting circuit

operation when measurements are being taken.

1.8 Overload Protection. Instrument accepts overload voltages of 250V dc or RMS ac on all ohms and dc current ranges, 250V dc or 1000V peak ac on all ac volt ranges, and 1000V dc or peak ac on all dc volt ranges. Positive overload indication is provided on the display.

## 1.9 SPECIFICATIONS.

1.10 Specifications are given in table 1.1.

**Table 1.1 - Danameter Specifications**

| GENERAL | |
|---|---|
| Operating Temp. Range: | 0 to +50°C |
| Storage Temp. Range: | –40°C to +65°C |
| Operating Humidity Range: | 0 to 75% R.H. |
| Size: | 7-1/2" wide x 4" high x 2-1/4" deep |
| Weight: | 1 pound with battery |
| Battery Type: | (1) standard 9V Dry Transistor battery Neda #1604 |
| Battery Life: | 1 year typical, 8 hrs./day |
| Shock: | Withstands 5 foot drop onto concrete floor |

## Table 1.1 - Danameter Specifications (continued)

| DC | |
|---|---|
| Ranges: | 2, 20, 200V, 1 KV |
| Overload Protection: | 1000V DC or peak AC, all ranges |
| Accuracy: | 2V<br>1 year, +5°C<br>±( 5[illegible] of reading + 1 dig.t)<br>typically<br>±( 2% of reading + 1 digit)<br>20, 200V, 1 KV<br>1 year, ±5°C<br>± 75[illegible] of reading + 1 digit<br>typically,<br>±(.2% of reading + 1 digit) |
| Polarity: | Automatic |
| Temperature Coefficient: | 0°C to 15°C, 35°C to 50°C<br>±(.025% of rdg + .05 digit)/°C |
| Input Resistance: | 10 Megohms, all ranges |
| NMR. | 50 dB M[illegible] at 60 Hz |
| Settling Time. | T[illegible] |

**NOTE**

Unless otherwise stated, all performance specifications are guaranteed for a period of 1 year.

| AC | |
|---|---|
| Ranges: | 2 20 200V 1 KV |
| Overload Protection: | 1000V [illegible] 250V DC Max |
| Accuracy: (From 45 Hz) | 2V<br>1 [illegible] +5°C to 2 kHz<br>± 2.5 [illegible] of reading + 2 digits<br>typically,<br>±( 3% of reading + 2 di[illegible]<br>20, 200V, 1 KV<br>1 year, ±5°C to 5 kHz<br>±(2.5% of reading + 2 digits)<br>typically,<br>[illegible] |
| Input Resistance | 2 Megohms |
| Input Capacitance | [illegible] |
| Settling Time | T[illegible] |

| OHMS | |
|---|---|
| Ranges: | 200Ω, 20 KΩ, 2 MΩ, and 200 MΩ |
| Overload Protection: | 250V DC or VRMS AC, all ranges |
| Accuracy: | 200Ω<br>1 year, ±5°C<br>±(3.5% of reading + 3 digits)<br>typically,<br>±(.9% of reading + 2 digits)<br>20 KΩ<br>1 year, ±5°C<br>±(1.5% of reading + 2 digits)<br>typically,<br>±(.3% of reading + 2 digits)<br>2 MΩ<br>1 year, ±5°C<br>±(3.5% of reading + 1 digit)<br>typically,<br>±(.9% of reading + 1 digit)<br>200 MΩ<br>1 year, ±5°C<br>±(8% of reading + 1 digit)<br>typically,<br>±(5% of reading + 1 digit) |

| OHMS (continued) | |
|---|---|
| Max. Current Through Unknown: | 1 milliampere |
| Voltage Across Unknown for Full Scale Indication: | 200Ω, 20K – 200 mV<br>2M, 200M – 2V |

| CURRENT (DC) | |
|---|---|
| Ranges: | 20 μA, 2 mA, 200 mA, and 2A |
| Accuracy: | 20 μA, 2 mA, 200 mA, 2A<br>1 year, ±5°C<br>±(2% of reading + 2 digits)<br>typically,<br>±(.8% of reading + 2 digits) |
| Settling Time: | Typically, ≤1 sec. |
| Voltage Burden: | .25V maximum up to 1/2 amps |
| Overload Protection: | 250V DC or VRMS, all ranges<br>(5 sec. max. 20 μA range) |

Table 1.1 - Danameter Specifications (continued)

## OPTIONS

### 1. MODEL 84 R.F. PROBE

| | |
|---|---|
| Accuracy: ±5°C, 6 mos. | (0 to 25V RMS Input)<br>1 kHz to 10 MHz<br>±(1% Input + 50 mV)<br>10 MHz to 100 MHz<br>±(12% Input + 50 mV)<br>100 MHz to 200 MHz<br>±(30% Input + 50 mV) |
| Input Impedance: | 1.6 MΩ shunted by 7 pF nominal |
| Maximum Input: | 125V rms AC 60 - 400 Hz<br>250V DC |

### 2. MODEL 82 HI VOLTAGE PROBE

| | |
|---|---|
| Accuracy: | (0 - 5 KV, 0 to 50°C)<br>±2% of input with 10 MΩ DMM load |
| Maximum Input: | 5 KV DC |
| Input Resistance: | 900 MΩ nominal |
| Division Ratio. | 1000:1 |

## OPTIONS

### 3. MODEL 83 HI VOLTAGE PROBE

| | |
|---|---|
| Accuracy: | (0 - 50 KV, 0 to +50°C)<br>±5% of input with 10 MΩ DMM load |
| Maximum Input: | 50 KV DC |

### 4. MODEL 86 AC CURRENT SHUNT SET

| | |
|---|---|
| Resistance Values: (Current Ranges) | 1.0 Ohm (0 - 1A)<br>1 Kohm (0 - 2 mA) |
| Accuracy: | Same as 2V A.C. range |
| Overload without Damage | 20 mA on 2 mA range<br>1A on 1A range, continuous<br>2A on 1A range, 2 minutes max. |

## 2.1 UNPACKING.

2.2 Your Danameter comes complete with battery and input probes. If either is missing or damaged notify your dealer immediately. Read the General Description to familiarize yourself with the instrument before attempting to install battery.

## 2.3 GENERAL DESCRIPTION.

2.4 Front Panel. The front panel of the Danameter is shown in figure 2.1. Important features of the front panel are listed in the following paragraphs.

a. Readout. The readout, located at the top left corner of the Danameter, is an easy-to-read, 4-digit, numeric display that also provides decimal, polarity, and overload indication.

b. Range/Function Switch. The range/function switch is a rotary 18-position control, located on the

right side of the instrument. This control selects four ranges of DC volts, four ranges of AC volts, four ranges of resistance measurements, four DC current measurement ranges, a battery test position, and OFF. The switch may be rotated in either direction.

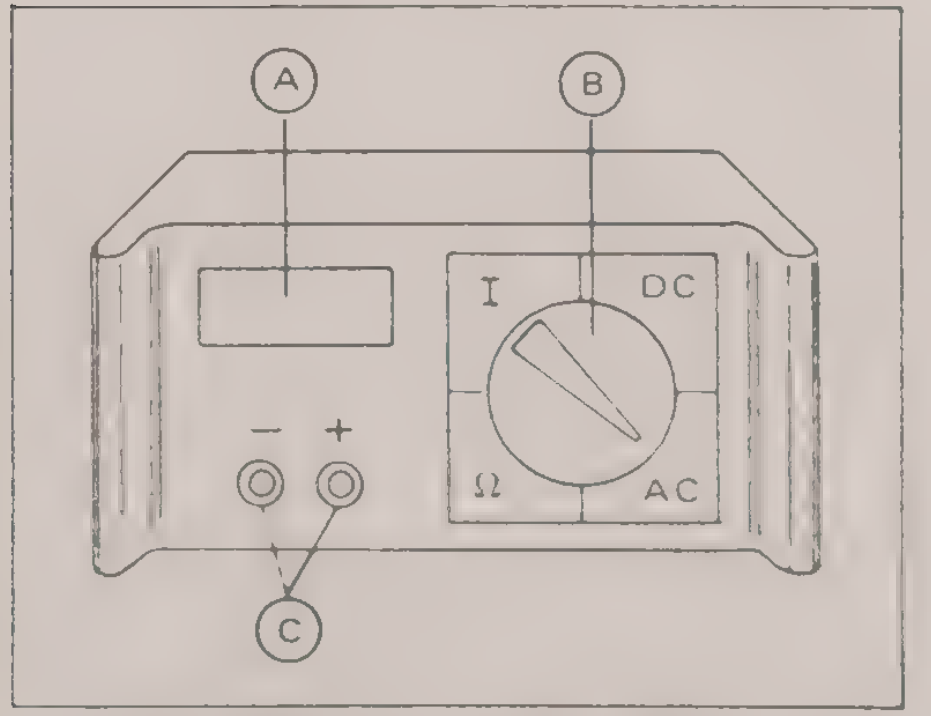



*Figure 2.1 - From Panel*

c. Input Jacks. Only two input jacks are required for all Danameter functions and ranges. These are located at the bottom left corner and marked + and ; the red probe is connected to the + Jack and the black probe is connected to the – Jack. For measurements

of DC voltage and current, the black probe (– Jack) is considered the reference; the Danameter display indicates + when measuring a signal more positive than the black probe and when measuring a signal more negative than the black probe.

2.5 Rear Panel. The rear panel of the Danameter is shown in figure 2.2. Important features of the rear panel are listed in the following paragraphs.

a. Bail. The bail is located in the upper portion of the rear panel and allows the instrument to be positioned at 45° and 75° angles

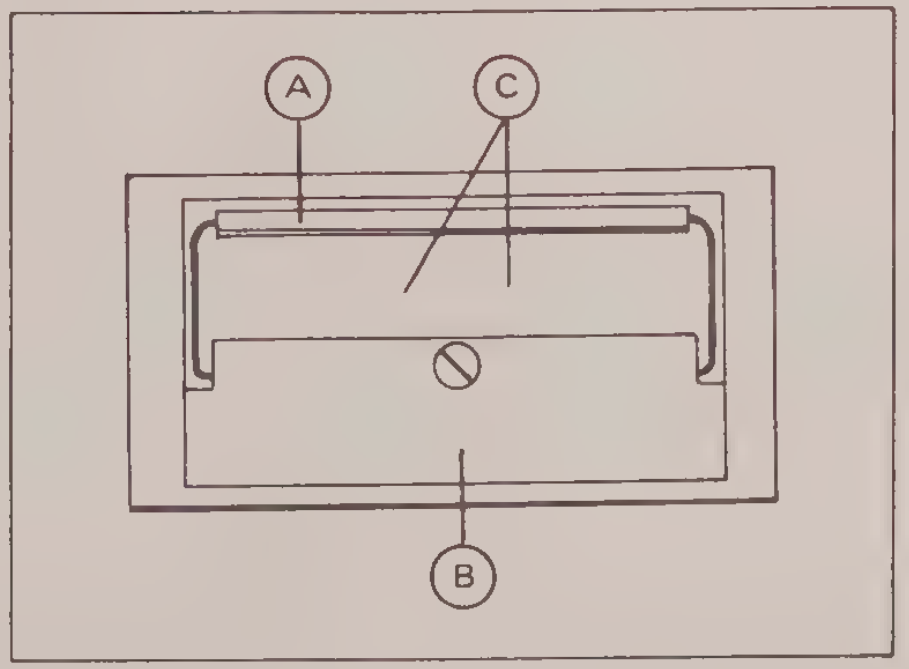



*Figure 2.2 - Rear Panel*

from the normal upright position. The bail can also be used as a handle to facilitate 2-hand operations.

b. Battery and Fuse Compartment. The battery and fuse compartment is located at the bottom of the rear panel. Both the battery and fuse are accessible by loosening the captive screw located in the center of the rear panel and sliding the cover towards the top of the instrument.

c. General Information Labels. General information about the Danameter is printed on the labels located on the upper portion of the rear panel. These labels describe battery type, fuse type, test voltages for the battery, and general cautions.

2.6 Battery Installation. The instrument is equipped with a 9-volt, transistor radio type dry battery which will provide about 1 year of service. A mercury or alkaline 9 volt replacement battery may be used with essentially equal service life.

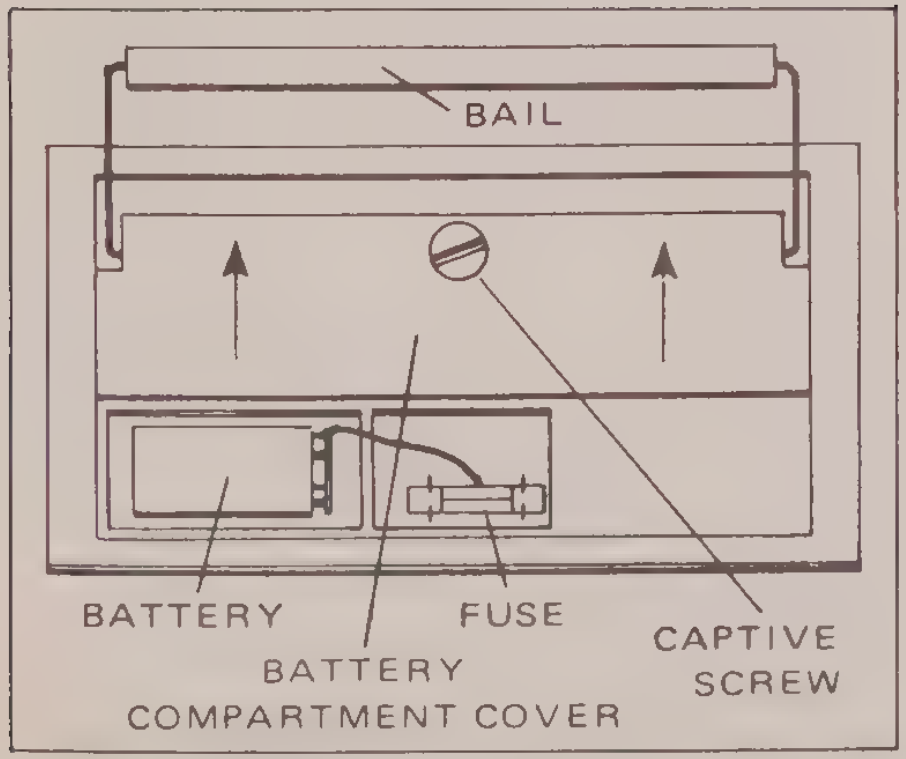



*Figure 2.3 - Battery Replacement*

When installing or replacing the battery, observe the following procedure (see figure 2.3).

a. Set the Danameter switch to OFF.

b. Loosen the captive screw located in the center of the back panel; swing the bail out and away from the back panel; slide the battery compartment cover up. The battery compartment cover and bail assembly can now be removed.

c. Match battery connector with mating terminals on battery and press. If properly aligned, connector will snap on easily. If not, recheck alignment.

d. Replace battery and fuse cover; tighten captive screw.

e. Set switch to TEST; a readout of greater than 600 indicates your Danameter is capable of making accurate measurements. A new battery will indicate from 800 to 1100.

## 2.7 MEASUREMENTS.

*WARNING*

*Exercise extreme caution when working near sources of high voltage. This includes any voltage measurements requiring the use of 200V or 1000V DC or AC ranges.*

## 2.8 General.

2.9 Standard measurement capabilities of the Danameter include DC and AC voltages, DC currents, and resistance. These

standard measurements utilize the probes provided with the instrument; with the black probe occupying the – input jack and the red probe occupying the + input jack.

## 2.10 Overload.

2.11 Overload is a built-in capability that protects the Danameter against damage and permits probing of unfamiliar circuitry where an overload condition may be encountered. An overload condition exists whenever the input signal to the Danameter is larger than the range selected and is indicated as OL on the display. For example, with the 200 Mohms range selected and the input leads open, the display reads OL since the input signal (infinite resistance) is greater than the 200 Megohm capability of the range.

2.12 The Danameter is protected by limiting the amount of current that is permitted to flow through it. The DC and AC volt ranges, most Ohms and 20 $\mu$A ranges are protected due to their high input impedance. The three higher DC current ranges and the 200$\Omega$ range are protected by a 2-1/2 amp fast-blow fuse in the

Danameter that blows when an excessive current is applied.

*WARNING*

*Do not rotate selector switch through dc CURRENT or OHMS ranges when a signal capable of producing an overload is applied to the input (e.g., 110 volts AC). Instantaneous fault currents well in excess of the fuse rating can occur resulting in severe damage to both the equipment under test and the Danameter's switches.*

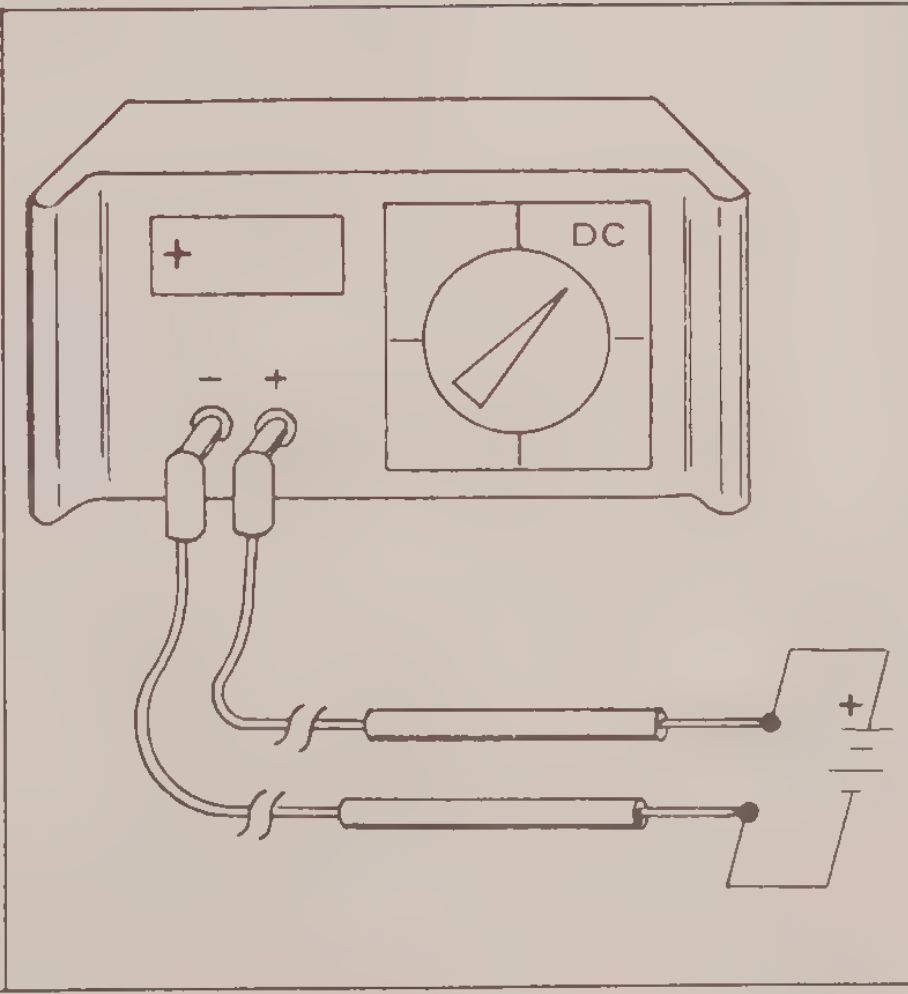
## 2.13 Procedures.

2.14 Tables 2.1 through 2.4 provide information for measuring on each function. In each case the sequence is the same:

1. Select appropriate range.
2. Connect test leads to circuit as shown.
3. Read value on display.

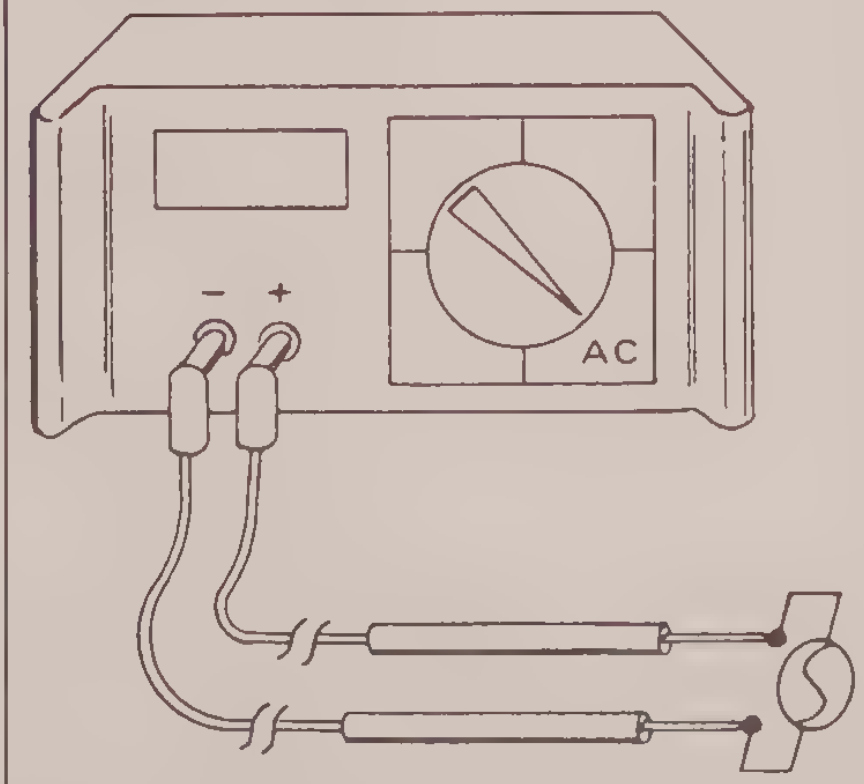
## Table 2.1 - DC Volts

| FULL SCALE INPUT | RESOLUTION | MAXIMUM INPUT: |
|---|---|---|
| ±1.999V | 1 MILLIVOLT | DC ± 1000 VOLTS |
| ±19.99V | 10 MILLIVOLT | AC 1000V PEAK (700V RMS) |
| ±199.9V | 100 MILLIVOLT | INPUT RESISTANCE: |
| ±1000V | 1 VOLT | 10 MEGOHMS |



## Table 2.2 - AC Volts

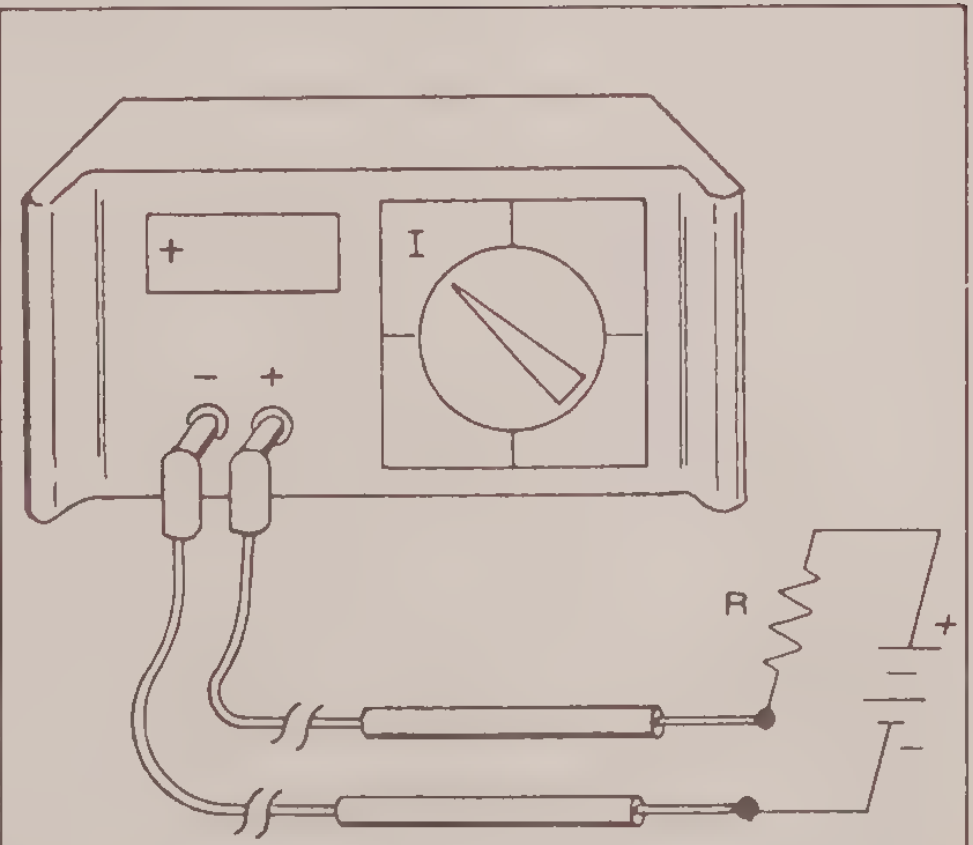
| FULL SCALE INPUT | RESOLUTION | FREQ * | MAXIMUM INPUT: |
|---|---|---|---|
| 1.999V | 1 MILLIVOLT | 45 Hz to 2 kHz | AC 1000V PEAK (700V RMS) |
| 19.99V | 10 MILLIVOLT | 45 Hz to 5 kHz | DC ± 250 VOLTS |
| 199.9V | 100 MILLIVOLT | | INPUT IMPEDANCE: |
| 700V | 1 VOLT | | 2 MEGOHMS |




*INDICATES HIGHEST MEASURABLE FREQUENCY WITH SPECIFIED ACCURACY
MEASURES TO 10 kHz ON ALL RANGES.

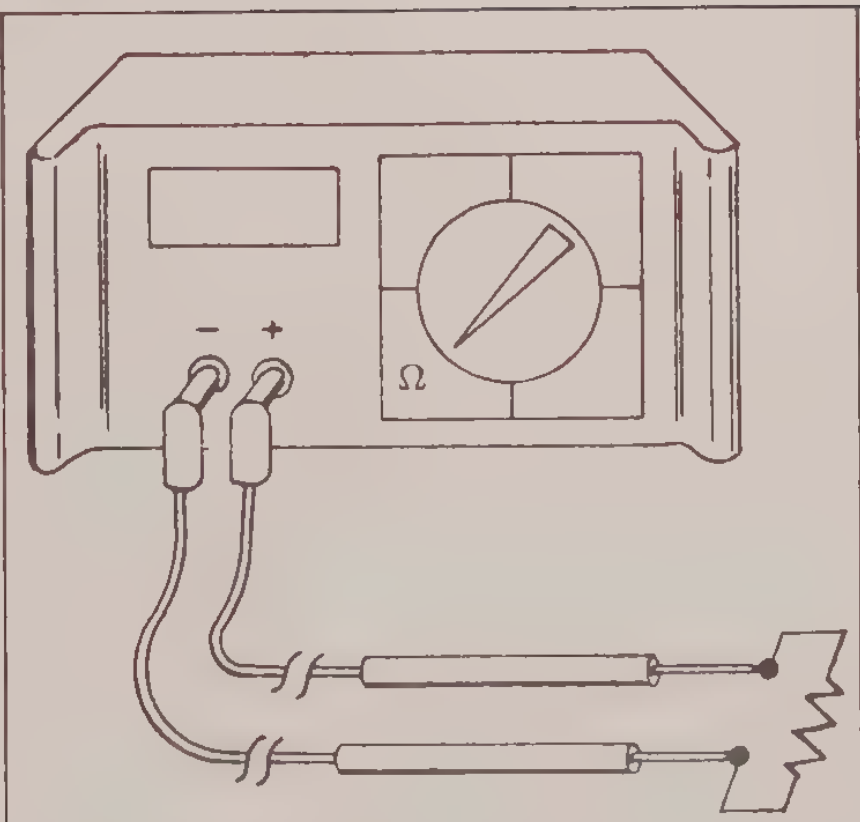
## Table 2.3 - DC Current

| FULL SCALE INPUT | RESOLUTION | MAXIMUM INPUT: |
|---|---|---|
| ±19.99 uA | 10 nA | WITHSTANDS 250V DC OR RMS AC FOR 5 SECONDS |
| ±1.999 mA | 1 μA | FUSE PROTECTED TO:<br><br>250 VDC<br><br>250 VRMS AC |
| ±199.9 mA | 100 μA | |
| ±1.999A | 1 mA | |



## Table 2.4 - Resistance

| FULL SCALE INPUT | RESOLUTION | CURRENT THROUGH UNKNOWN | MAXIMUM INPUT: |
|---|---|---|---|
| 199.9Ω | 100 mΩ | 1 MILLIAMP | 250 VDC |
| 19.99 KΩ | 10Ω | 10 MICROAMPS | 250 VRMS AC |
| 1.999M | 1 KΩ | 1 MICROAMP | |
| 199.9M | 100 MΩ | 10 NANOAMPS | |




TO EXTEND BATTERY LIFE, DO NOT LEAVE DANAMETER IN RESISTANCE FUNCTION, WHEN NOT IN USE.

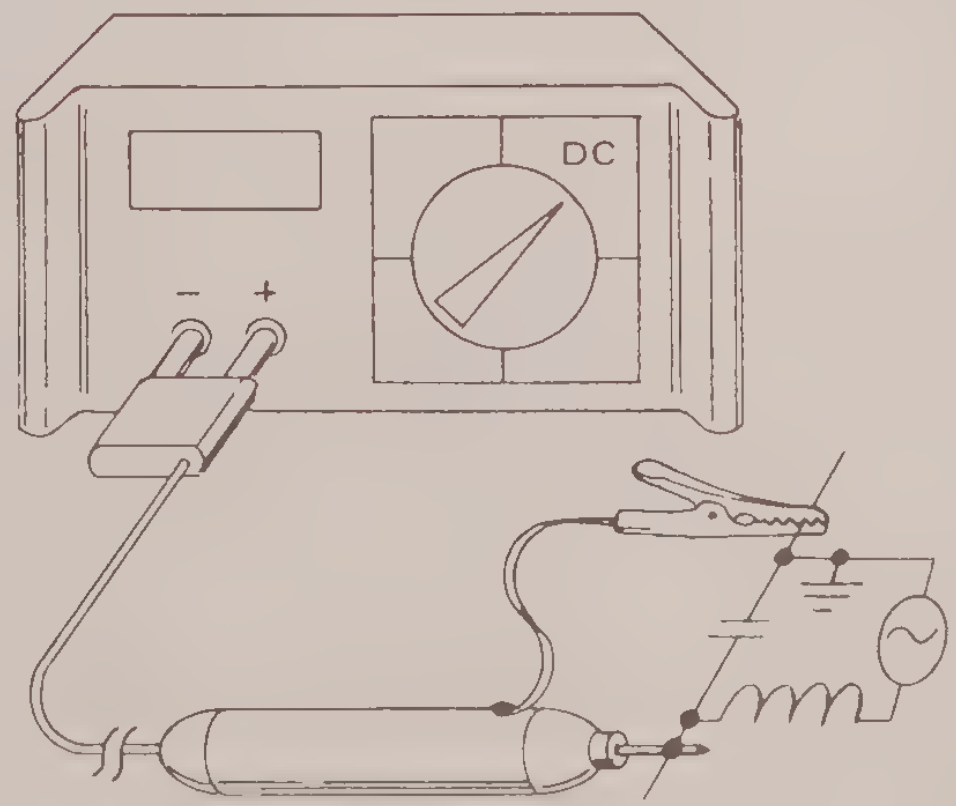
## 2.15 RF Probe (84).

2.16 The RF probe accessory extends the ac measuring capability of the Danameter to 200 MHz. The AC probe replaces the standard input probes and the polarity indications on the RF probe connector should be matched with the indications on the Danameter front panel. The probe is a peak sensing, RMS calibrated device and converts the ac input to an equivalent dc level which is then measured by the dc function of the meter. The probe accurately measures RF voltage up to 25 volts RMS from 1 kHz to 200 MHz. The probe is clamp protected for voltages to +250V dc or RMS ac without damage to the probe.

2.17 As shown in table 2.5, the shield clip is connected to the RF ground portion of the circuit being measured and the tip of the probe is held to the 'HOT' side of the RF circuit. The dc equivalent of the RF output is read on the Danameter display (the 2 VDC, 20 VDC, or 200 VDC ranges are used; 1V RMS = 1 VDC).

## Table 2.5 - RF Voltage (With RF Probe Accessory)

| FREQUENCY RANGE | ACCURACY |
|---|---|
| 1 kHz - 10 MHz | ±(1%r+0.5%F.S.) ON 20V RANGE |
| 10 MHz - 100 MHz | ±1 dB |
| 100 MHz 200 MHz | +3 dB |
| MAXIMUM READING: 25 VOLTS RMS | |
| INPUT IMPEDANCE: 1.6 MΩ | |



## 2.18 High Voltage Probe (82).

*DANGER*

*The High Voltage Probe is used for measuring potentially lethal voltage levels. Always remove power to and discharge the source before connecting or removing the High Voltage Probe from the source.*

2.19 The Danameter can be used to measure dc voltages to 5,000 volts with the use of the High Voltage accessory. This probe replaces the standard input leads and polarity indications on the High Voltage Probe connector must be matched with the indications on the Danameter for proper polarity indication.

2.20 As shown in table 2.6, the black lead of the High Voltage Probe is always connected to the grounded or low side of the source. The probe is a precision 1000:1 voltage divider; a maximum input of +5,000 volts is read as +5.0 volts on the 20 DCV scale. The 2V and 20V ranges are normally used; 1 KV measured equals 1V on the Danameter

## Table 2.6 - High Voltage (With 5 KV High Voltage Accessory)

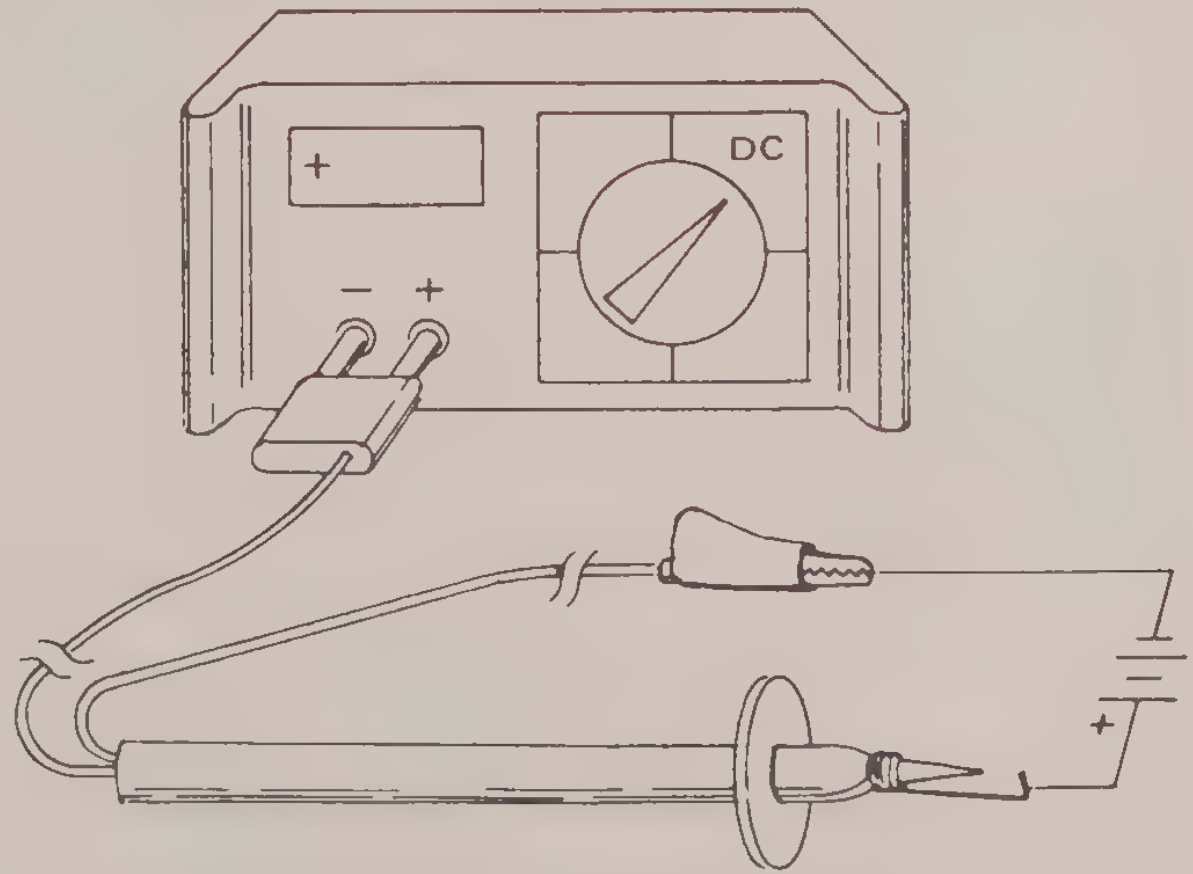
MAXIMUM INPUT:

5 KV

ACCURACY: ±2%

INPUT RESISTANCE:

900 MΩ



## 2.21 High Voltage Probe (83).

*DANGER*

*The High Voltage Probe is used for measuring potentially lethal voltage levels. Always remove power to and discharge the source before connecting or removing the High Voltage Probe from the source.*

2.22 The Danameter can be used to measure dc voltages to 50,000 volts with the use of the High Voltage accessory. This probe replaces the standard input leads and polarity indications on the High Voltage Probe connector must be matched with the indications on the Danameter for proper polarity indication.

2.23 As shown in table 2.6, the black lead of the High Voltage Probe is always connected to the grounded or low side of the source. The probe is a precision 1000:1 voltage divider: a maximum input of +50,000 volts is read as +50.0 volts on the 200 DCV scale. The 2V, 20V, and 200V ranges may be used: 1 KV measured equals 1V on the Danameter.

## Table 2.7 - High Voltage (With 50 KV High Voltage Accessory)

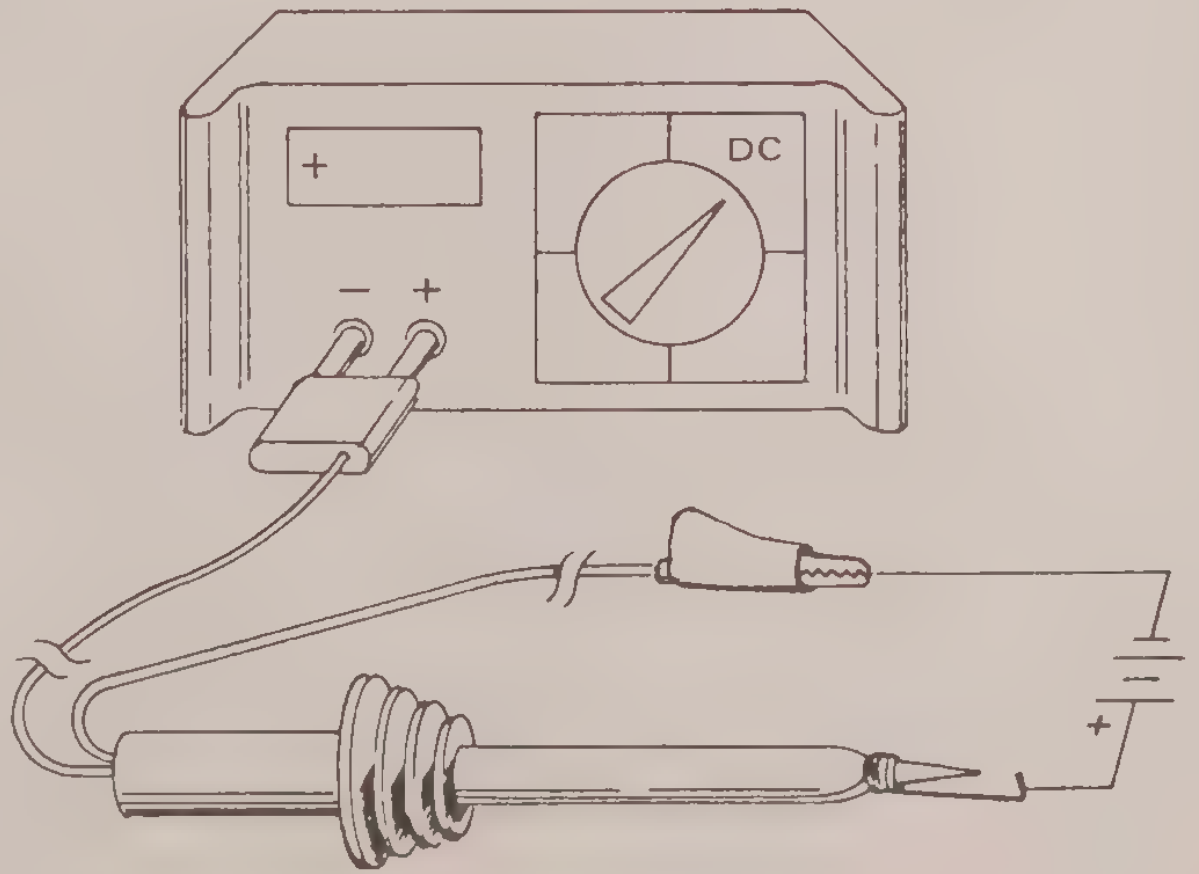
MAXIMUM INPUT:

50 KV

ACCURACY: ±5%

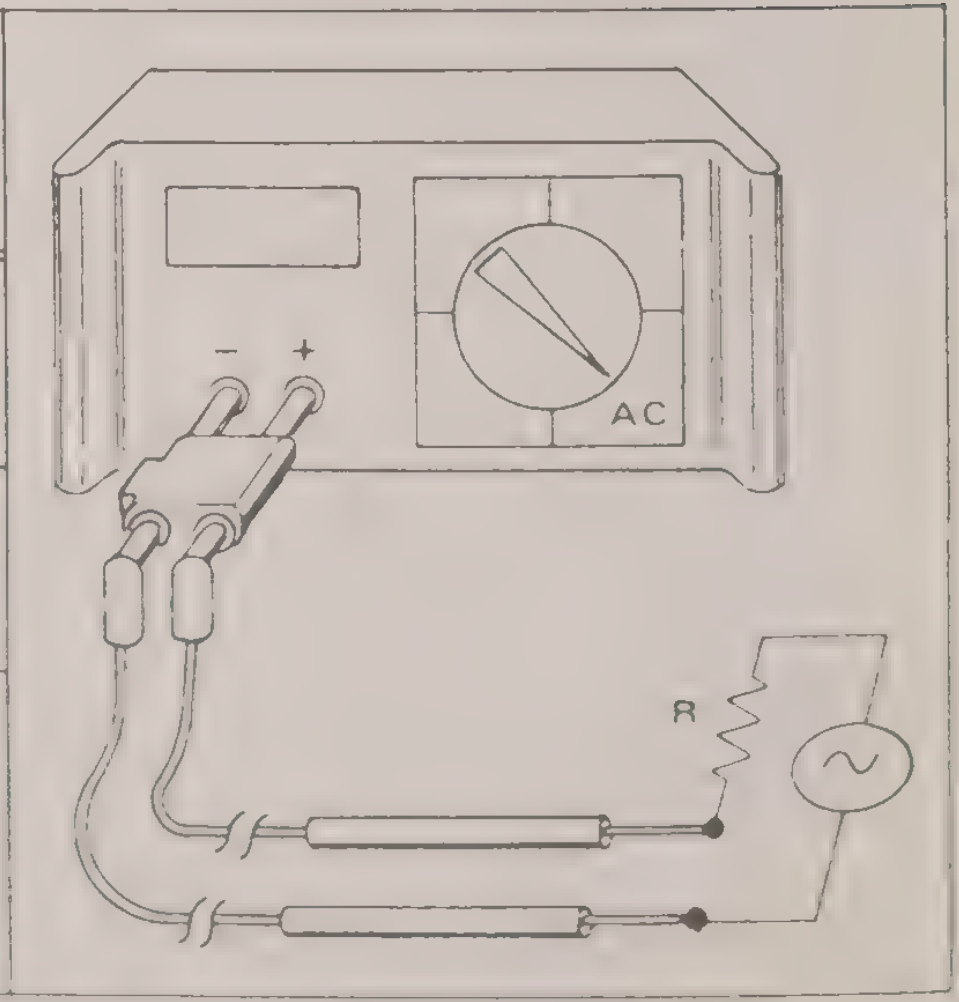
INPUT RESISTANCE:

900 MΩ



## Table 2.8 - AC Current (With AC Current Shunt Set)

| FULL SCALE INPUT | RESOLUTION | MAXIMUM INPUT |
|---|---|---|
| 1 999 mA | 1 μA | 20 mA |
| 1 AMP | 1 mA | 2 AMPS FOR 2 MIN MAX. |



## 2.24 AC Current Shunt Set (86).

2.25 The AC Current Shunt Set consists of two color coded precision current shunts. Each shunt consists of a precision resistor wired across two combination "banana" plug/jacks and are molded in plastic. The shunts are used on the AC 2V range and provide ac current measurements of 0 to 2 milliamps (orange shunt) and 0 to 1 amp (black shunt).

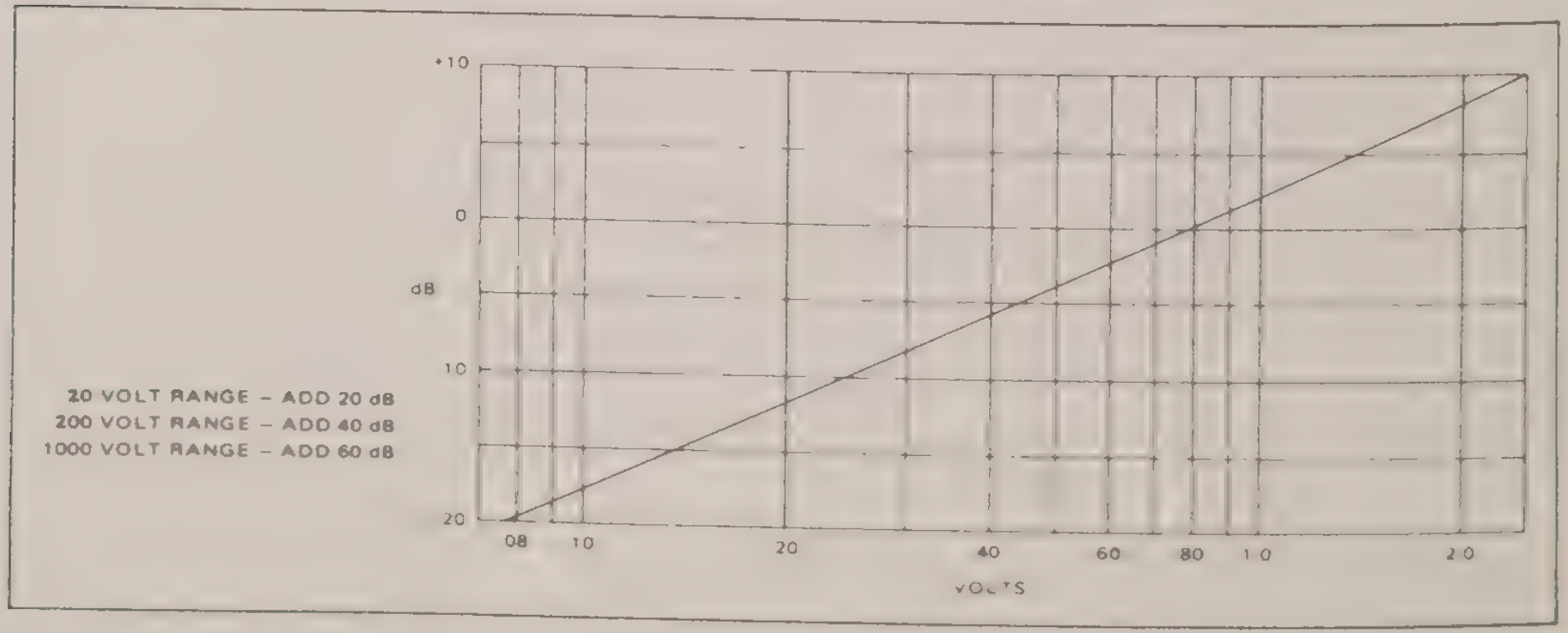
2.26 As shown in table 2.8, the banana plugs of the shunt fit directly into the Danameter input jacks. The input cable or leads plug into the jacks of the current shunt.

## 2.27 Decibels.

2.28 The gain and accuracy of electronic equipment is often expressed in dB or decibels. The dB is the logarithm of the ratio of two electrical signals; normally

a certain amount of power across a fixed resistance is used as a reference and denoted as 0 dB. One of the most common of this standard defines 0 dB as 1 milliwatt into 600 ohms and is used for our example.

**Table 2.9 - Decibel Conversion Chart**



2.29 A conversion chart for converting AC voltage measurements to dB is provided in table 2.9.

## 2.30 Diode and Transistor Check.

2.31 The Danameter is particularly useful for checking diode and transistor junctions. This is a common 'first pass' approach in looking for bad components when troubleshooting electronic equipment. The low current and open terminal voltage produced by the meter during resistance measurements virtually eliminates the possibility of damage to low-power semiconductor junctions, a danger prevalent in many types of analog meters.

2.32 Diodes exhibit a characteristic curve similar to the one shown in figure 2.4. The figure illustrates that measurements taken in the forward direction (– Lead to K and + Lead to A) have a much lower value than measurements taken in the reverse direction (typically 100 times lower or more). The meter reading in the forward direction does not reflect an actual value of resistance; the diode is a non-linear device and the reading reflects the voltage drop at a fixed current. The measurement in the reverse

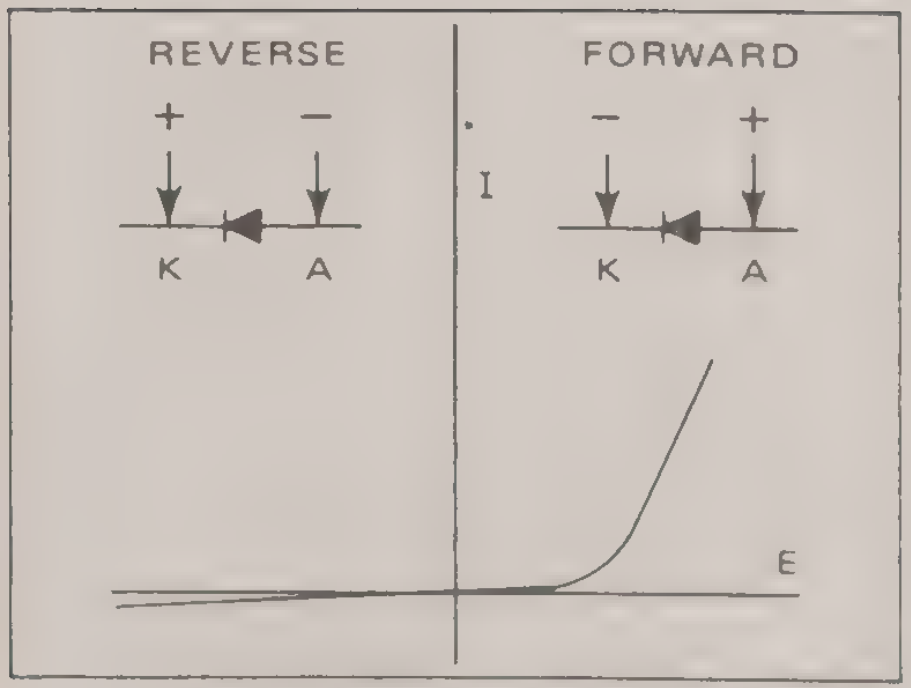



*Figure 2.4 - Diode Curve*

direction is due to leakage, it is linear, and usually of less interest than the forward characteristic (unless the meter reading is unusually low, indicating the device is bad).

2.33 For measuring junctions, the 2 Mohm resistance range is used. Actual readings vary, depending on the type of device. The normal range of readings taken on the 2M range is shown below.

2.34 Transistors are checked in the same manner as diodes by measuring the

| Material | Forward Reading | Reverse Reading |
|---|---|---|
| Silicon | .250 to .550 | OL |

two diode junctions formed between the base and emitter and the base and collector. To complete the test of transistors, measurements across the collector and emitter are taken in both directions, to determine if a short is present. Meter lead connections to diodes and transistors are shown in figure 2.5.

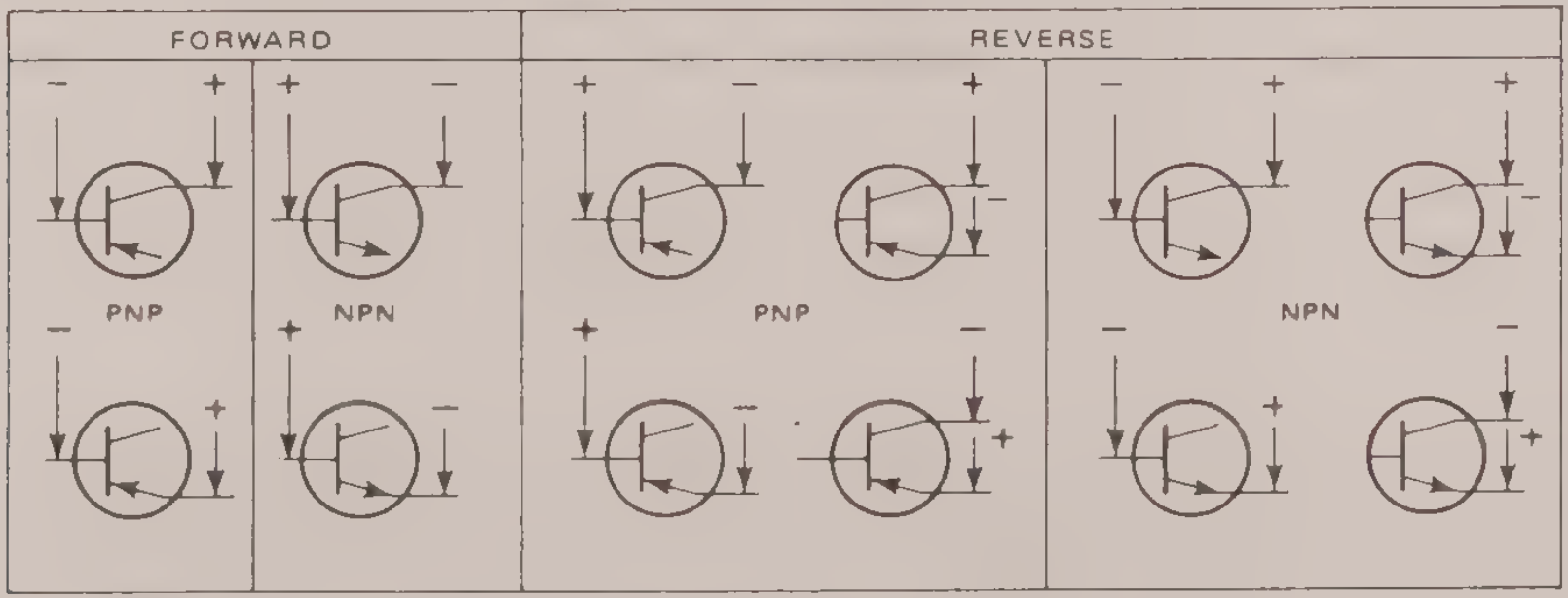



*Figure 2.5 - Transistor Checks*

# SECTION 3 THEORY OF OPERATION

## 3.1 GENERAL.

3.2 Mechanically, the Danameter is a completely self contained solid-state, Volt-Ohm-Milliampmeter with all active components contained in two Large Scale Integration (LSI) devices. Electrically, the Danameter converts a signal at its input jacks to a number at its display window, by a process called Dual-Slope Integration. Integration identifies the process as one in which the value of the input signal is converted to a proportional period of time; the amount of time produced is measured and displayed. Dual-slope identifies the type of integration and is so called because of the characteristic electrical output of one of the circuits used in this process.

3.3 The following discussion serves to identify and describe the major portions of the circuitry used in the instrument, shown simplified in figure 3.1.

3.4 Signal Conditioning. This circuitry modifies the input signal when required to make it compatible with the measurement circuitry. These modifications include:

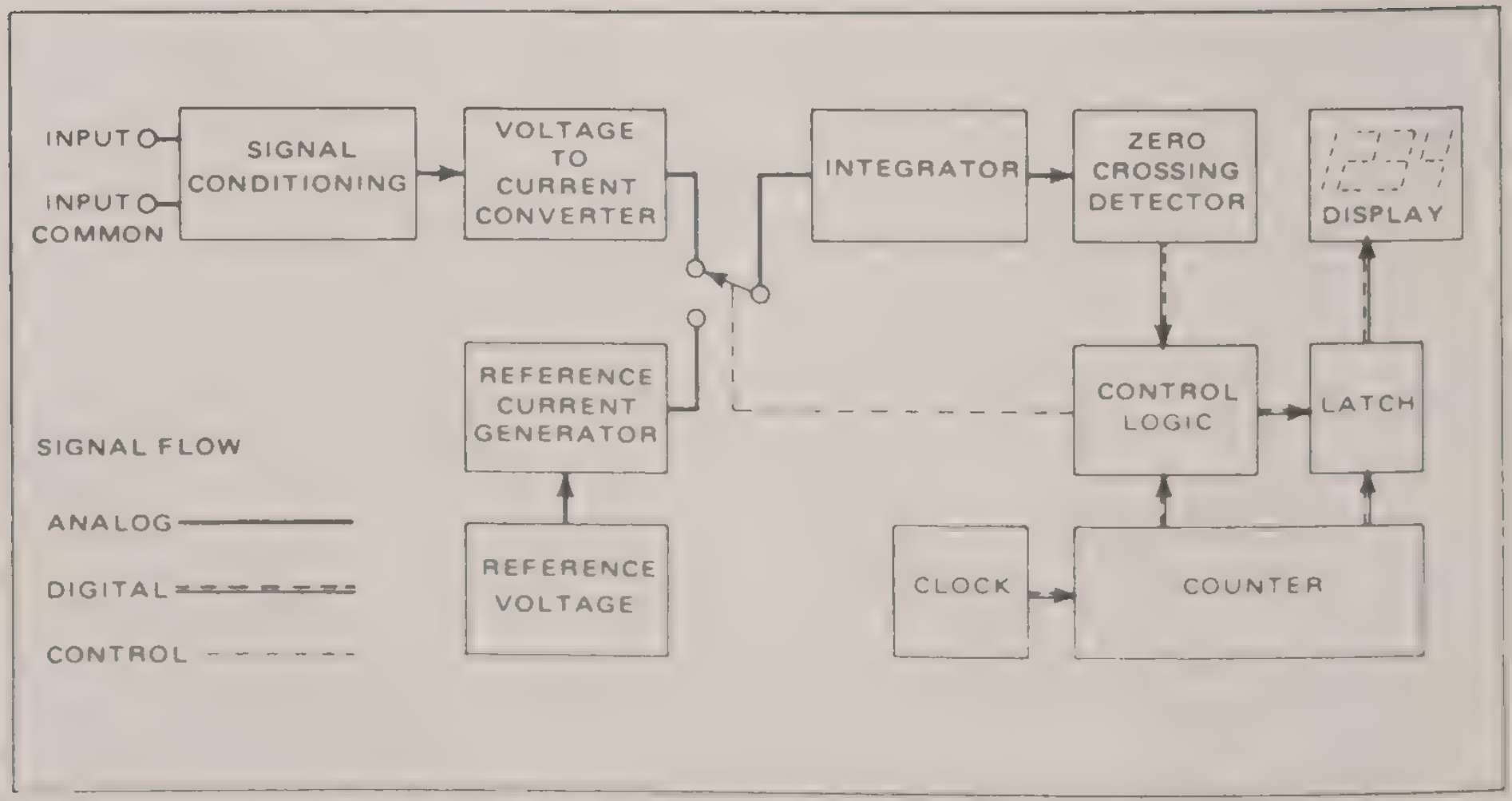



*Figure 3.1 - Danameter Simplified Drawing*

converting AC, resistance, and current inputs to a DC voltage level, scaling the input signal on the higher voltage ranges, and filtering the signal to attenuate any accompanying noise.

3.5 Voltage to Current Converter. This circuitry converts the conditioned input signal to a proportional amount of positive current for use during the measurement cycle.

3.6 Reference Voltage. It is generated by a stable 1.2 volt diode, used as the primary reference source for the Danameter.

3.7 Reference Current Generator. This circuit converts the reference voltage to a stable and accurate negative current for use during the measurement cycle.

3.8 Integrator. This circuit converts currents applied to it to a voltage ramp. The direction of the ramp is dependent on the polarity of the current; the slope of the ramp is directly proportional to the amount of current. The input of the integrator is switched to either the voltage-to-current converter or the reference current generator by the control logic. Basically, the integrator converts the input signal into a proportional time period.

3.9 Zero Crossing Detector. This circuit monitors the output of the integrator and initiates a signal when the integrator output returns to its starting point.

3.10 Clock. The clock generates an 8 kHz square wave output used to advance the counter.

3.11 Counter. The counter is a digital circuit that is continually advanced by the clock, linearly counting from 0000 to 3999 and overflowing back to 0000. The counter measures the time period of the integrator and provides the timing required by the logic.

3.12 Control Logic. The control logic circuitry receives inputs from the counter and the zero crossing detector and from this data, controls the switching of the integrator input and the strobing of the latch.

3.13 Latch. The latch is a storage circuit for the counter. Upon command from the control logic, the latch stores the number of counts accumulated in the counter.

3.14 Display. This includes a decoder AC driver circuit and the liquid crystal display. The decoder driver circuitry

converts the count information stored in the latch to a 7-segment code for use by the display assembly. The information stored in the latches appears as a number in the display window.

## 3.15 Integration.

3.16 Integration is a two phase process and is shown graphically in figure 3.2. The first phase is called signal integration. This is a clock and counter controlled time period of 125 ms, or the time required for the counter to advance from 3000 to 0000 (1000 counts). During this period the conditioned signal from the input is converted to a proportional

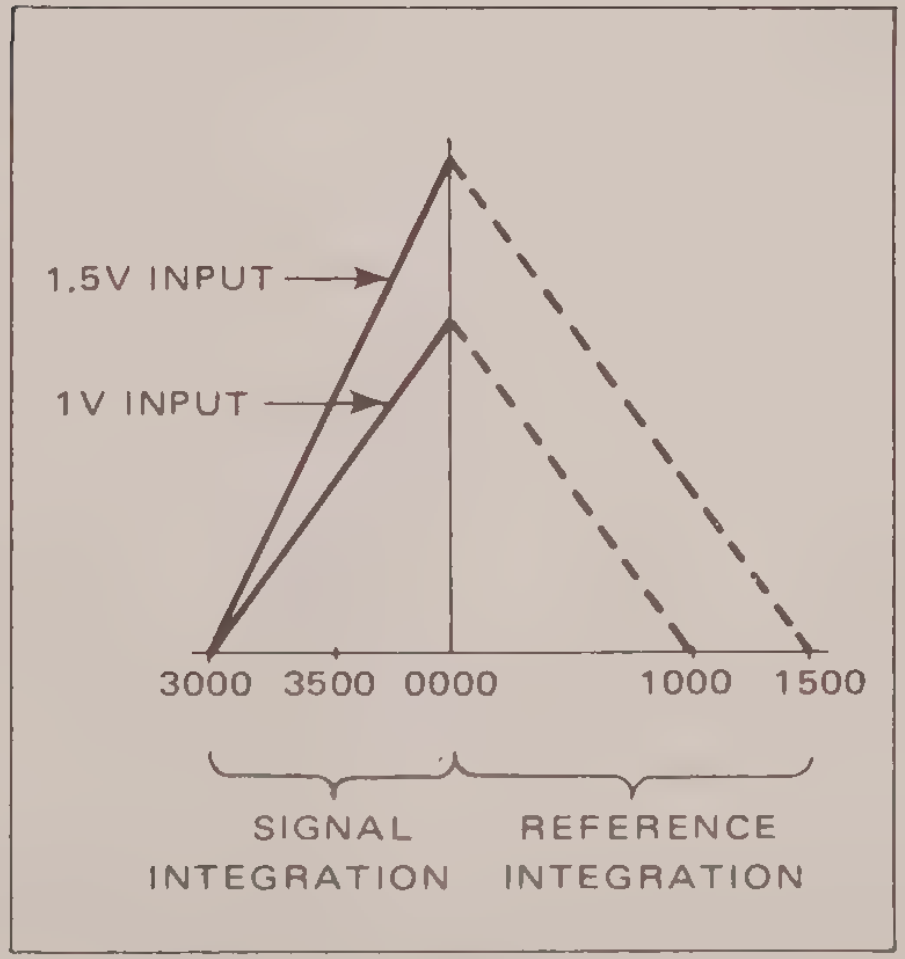



*Figure 3.2 - Integrator Output*

amount of positive current and fed to the integrator, resulting in a linearly increasing voltage potential. The rate of the increase is directly proportional to the input signal.

3.17 The second phase begins when the counter reaches 0000; the conditioned and converted input signal is removed from the integrator and replaced by a fixed amount of negative current. This reference current causes the output of the integrator to decrease at a fixed linear rate. When the output of the integrator returns to its original level, the zero crossing detector generates a signal that:

a. Disconnects the integrator from the reference current generator.

b. Commands the latches to store the setting of the counter.

The counter does not stop when the zero crossing detector signal is produced; it continues to advance until it reaches 3000 which starts a new measurement cycle. The information stored in the latches is converted to numbers on the display and is an accurate representation of the input signal.

## 4.0 MAINTENANCE.

### 4.1 Battery Replacement.

Suitable replacement batteries are:

| | |
|---|---|
| Burgess 2U6 | Panasonic 006P |
| Eveready 216 | Ray-O-Vac 1604 |

or equivalent.

4.2 Battery replacement is covered in paragraph 2.6.

### 4.3 Fuse.

4.4 The fuse provides overload protection on some DC current ranges and is electrically in series with the – input lead. The fuse is located next to the battery and access to the fuse is the same as described in paragraph 2.6. The fuse is a type 3AG/AGC 2.5 Amp, 250 volt.

*CAUTION*

*Do not substitute a different value or a slo-blow type fuse in this instrument.*

## 4.5 Calibration.

4.6 Calibration returns the operation of your Danameter to its original specifications and is performed when the highest measurement accuracy is required. Calibration is available through your dealer. For those who desire to perform their own calibration and possess the necessary equipment, the following information is provided.

4.7 ACCESS TO CALIBRATION POINTS.

4.8 To calibrate the Danameter it is first necessary to remove the back cover. This is accomplished as follows:

1. Set Danameter control switch to OFF.
2. Loosen captive screw on battery cover.
3. Swing bail away from back of instrument and slide cover up.
4. Remove mounting screw at center of back.
5. Remove battery and fuse. Lift off back and guide battery cable through hole in back cover. Reconnect battery and fuse.

4.9 REQUIRED EQUIPMENT.

4.10 Equipment required to fully calibrate the Danameter is shown in table 4.1. The types of equipment listed is for reference only and equipment with suitable characteristics may be substituted.

4.11 CALIBRATION PROCEDURE.

4.12 Referring to table 4.2, select the function and range on the Danameter, connect the input leads across the standard, and adjust the control for the required reading for each step. Calibration points are shown in figure 4.1. (NOTE: use a mirror placed in front of the Danameter to facilitate adjustment.)

4.13 Reassemble the Danameter by reversing the procedure of paragraph 4.11. (Insure Danameter is "OFF" when installing battery.)

**Table 4.1 - Required Equipment**

| Name | Required Accuracy | Recommended Type |
|---|---|---|
| DC Standard<br>AC Standard<br>DC Current Standard<br>Resistance Standard | .05% | ROTEK AC/DC Precision Calibrator Model 310 |
| Adjustment Screwdriver (Jewelers $\leq$ .060") | — | — |
| Cliplead $\approx$ 6" long | — | — |

## Table 4.2 - Calibration Procedure

| Switch Setting | Hookup or Input | Adjust | For Readout of: |
|---|---|---|---|
| 1. 200 mA | Jumper between TP1 & TP2 | R30 | Zero with alternate + and − sign |
| | Remove jumper | R3 | |
| 2. 2 VDC | DC Standard +.001 volt | R33 | +.001 (± 1 digit) |
| | DC Standard +1.900 volts | R35 | +1.900 (± 1 digit) |
| 3. 20 VAC | AC Standard 19.00V @ 400 Hz | R14 | 19.00 (±2 digits) |
| 4. 20KΩ | Ohms Standard 19.00 KΩ | R5 | 19.00 (±2 digits) |

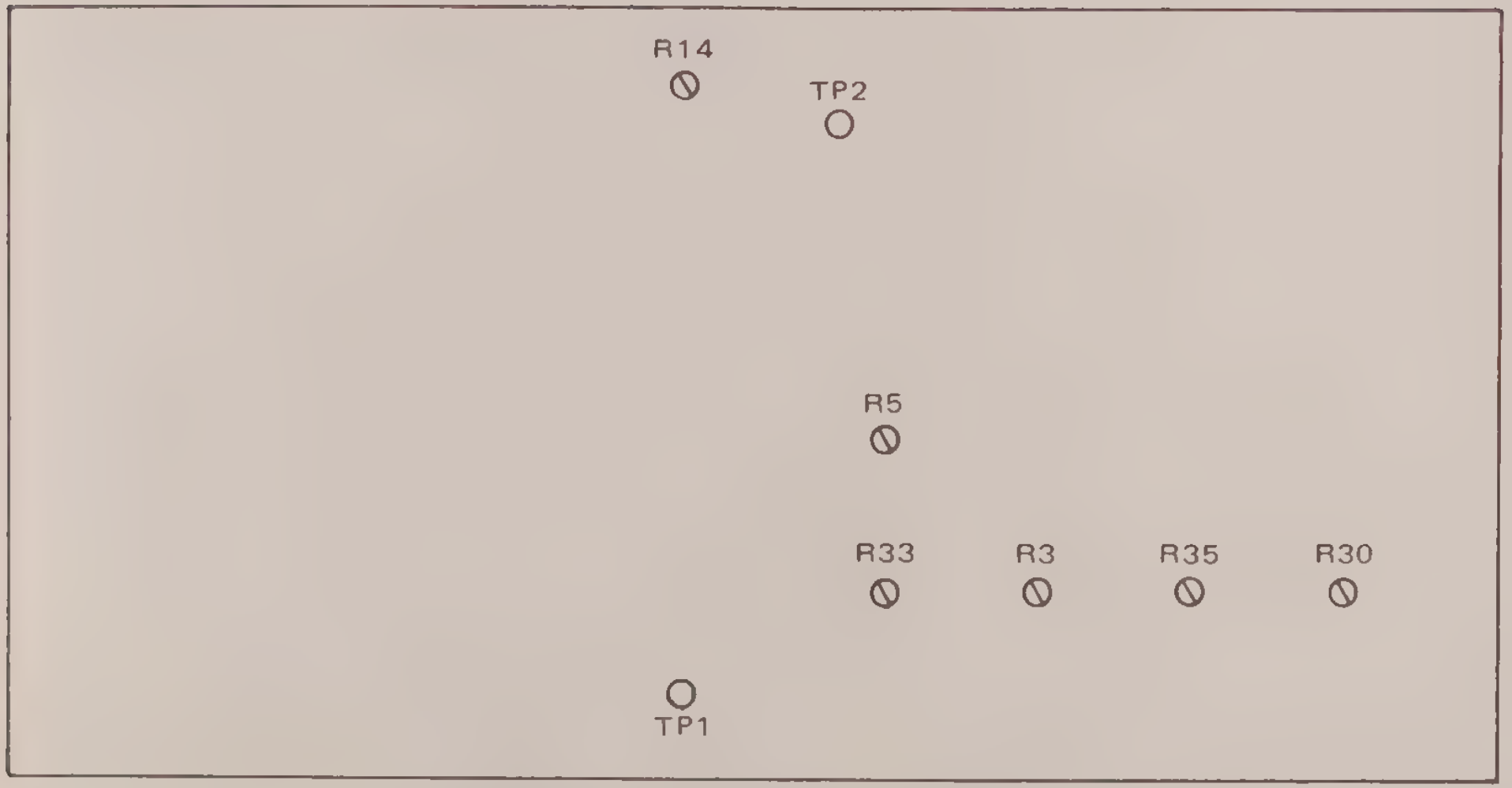
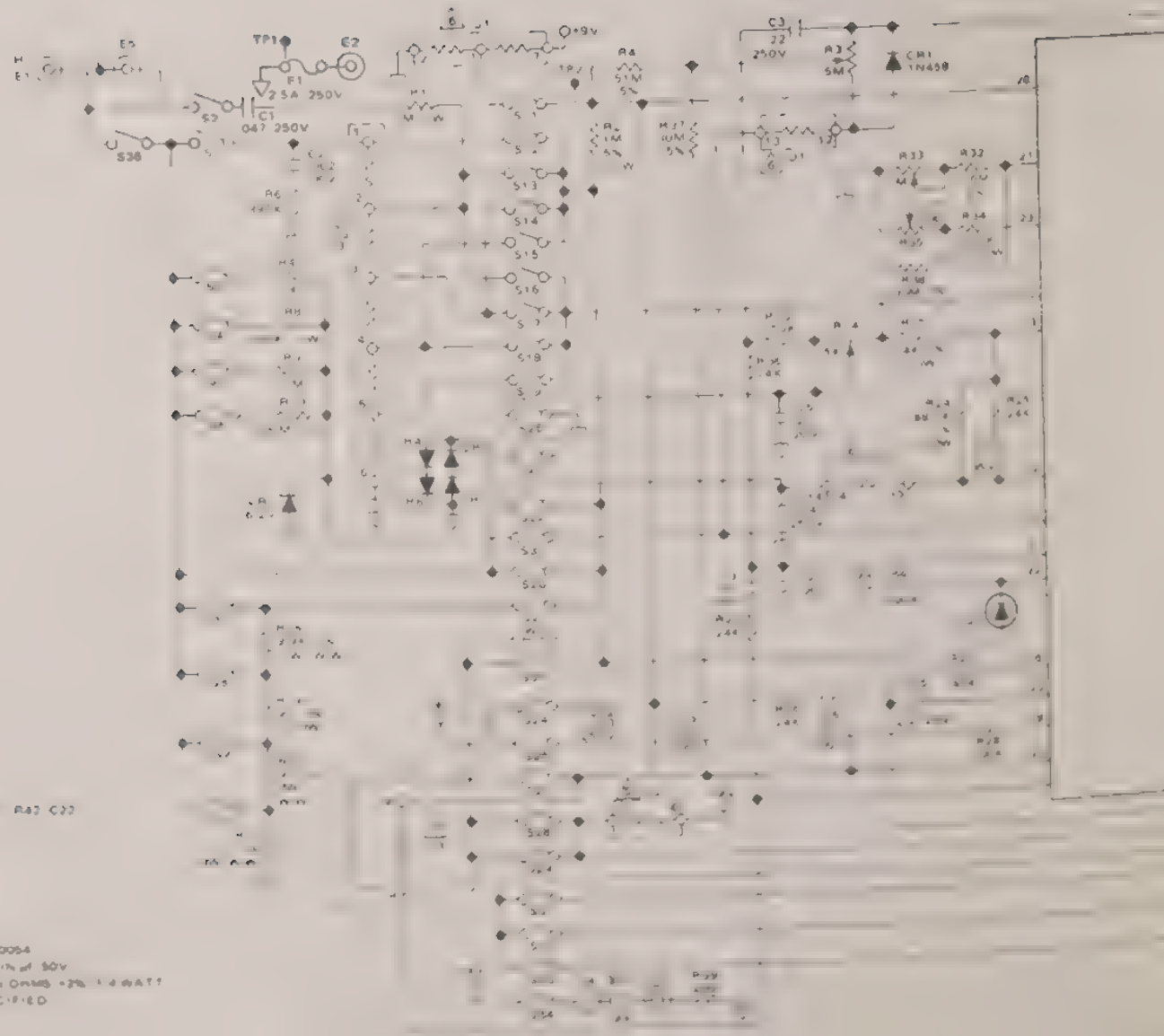



*Figure 4.1 - Calibration Points*




8 LAST REF DES GNATORS USED R47 C32
CR10 VR2 S37 U5

⚠4 DANA P/N 010848

⚠5 DANA P/N 010846

⚠6 DANA P/N 010847

2. ALL DIODES ARE DANA P N 210054
3. ALL CAPAC TOR VALUES ARE IN pf 50V
4. ALL RES STOR VALUES ARE N OHMS ±2% 1/4 WATT
NOTES UNLESS OTHERWISE SPECIFIED

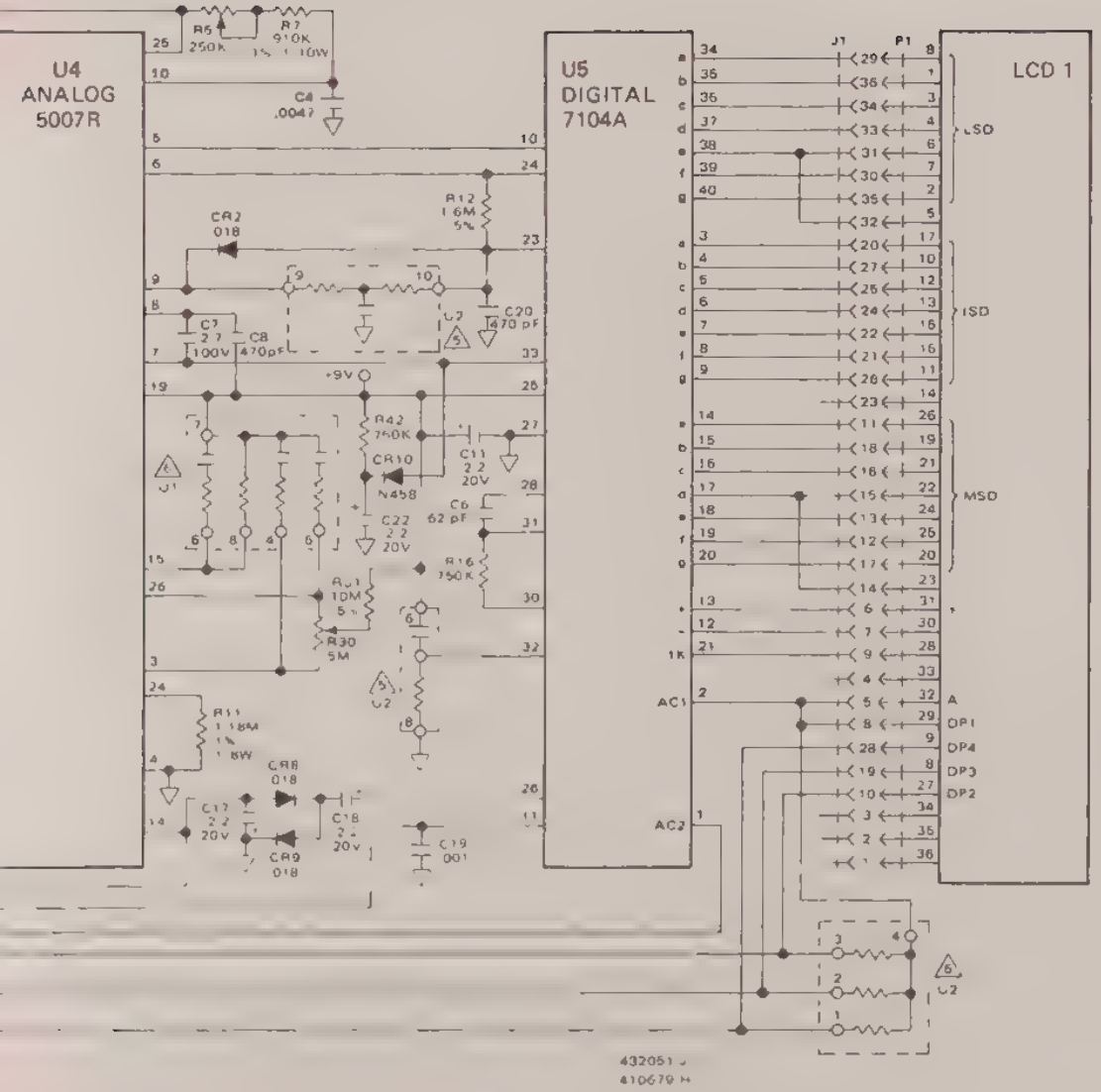



*Figure 4.2 - Schematic, Danameter*

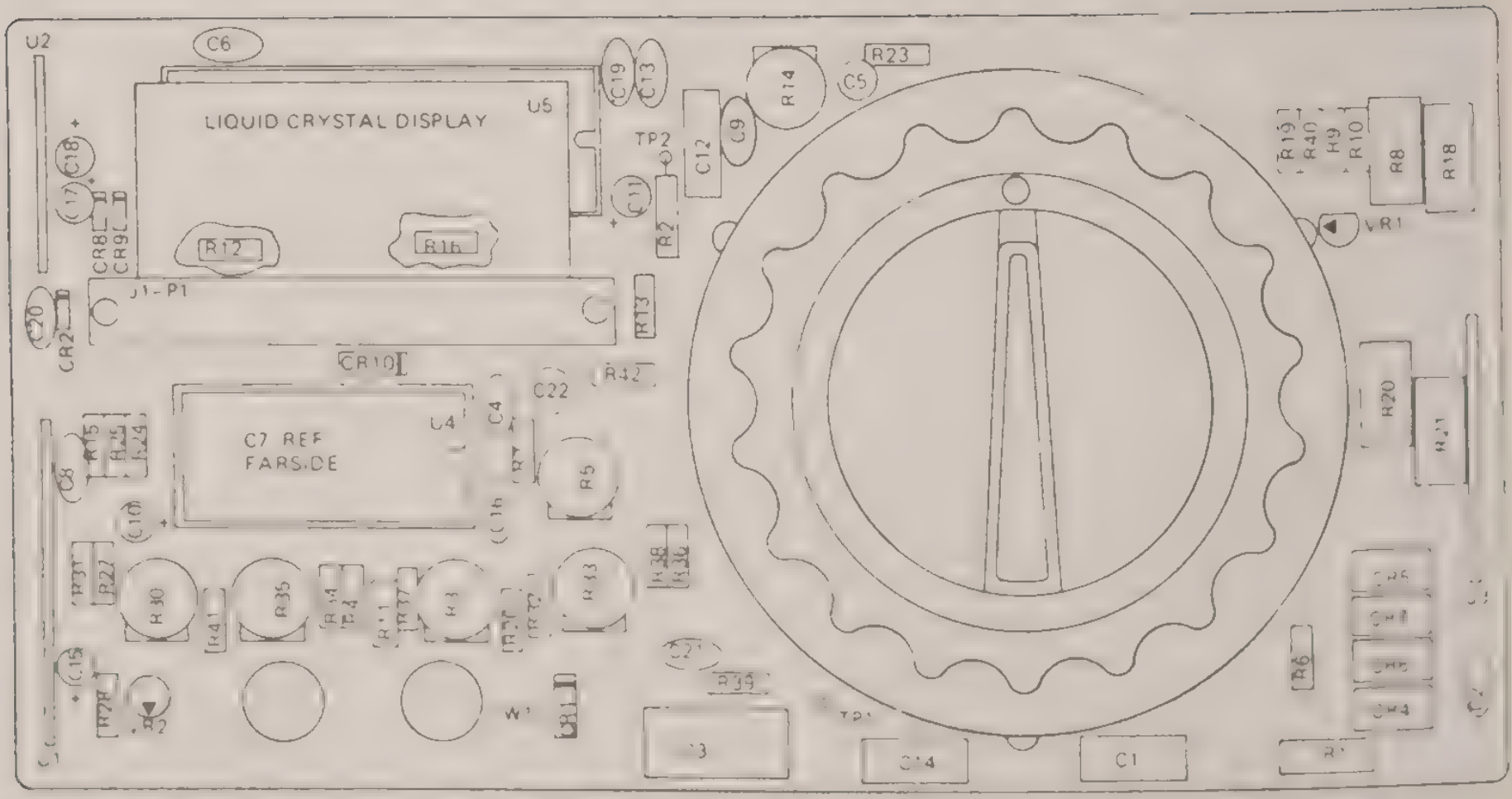



*Figure 4.3 - Layout, Danameter*

# Table 4.3 - Parts List

| REF DESIG | P/N | DESCRIPTION | | | | |
|---|---|---|---|---|---|---|
| C1 | 120321 | CAP | MYLAR | .047 µF | 250 V | ±10% |
| C2 | 100109 | CAP | DISC | .002 µF | 1 KV | +50%−20% |
| C3 | 120322 | CAP | MYLAR | .22 µF | 250 V | ±10% |
| C4 | 100110 | CAP | DISC | 4700 pF | 50 V | ±20% |
| C5 | 110166 | CAP | TANTA | 2.2 µF | 20 V | ±20% |
| C6 | 100105 | CAP | DISC | 62 pF | 50 V | ±5% |
| C7 | 120323 | CAP | MYLAR | 2.7 µF | 100 V | ±10% |
| C8 | 100117 | CAP | DISC | 470 pF | 50 V | ±20% |
| C9 | 120332 | CAP | POLYFILM | 0.01 µF | 100 V | |
| C10 | 110168 | CAP | TANTA | .1 µF | 35 V | |
| C11 | 110166 | CAP | TANTA | 2.2 µF | 20 V | ±20% |
| C12 | 120320 | CAP | MYLAR | .033 µF | 250 V | ±10% |
| C13 | 120330 | CAP | POLYFILM | .001 µF | 100 V | ±20% |
| C14 | 120321 | CAP | MYLAR | .047 µF | 250 V | ±20% |
| C15 | 110166 | CAP | TANTA | 2.2 µF | 20 V | ±20% |
| C16 | 120332 | CAP | POLYFILM | 0.01 µF | 100 V | |
| C17 | 110166 | CAP | TANTA | 2.2 µF | 20 V | ±20% |
| C18 | 110166 | CAP | TANTA | 2.2 µF | 20 V | ±20% |

## Table 4.3 - Parts List (continued)

| REF DESIG | P/N | DESCRIPTION | | | | |
|---|---|---|---|---|---|---|
| C19 | 100108 | CAP | DISC | .001 µF | 50 V | ±10% |
| C20 | 100117 | CAP | DISC | 470 pF | 50 V | ±20% |
| C21 | 100108 | CAP | DISC | .001 µF | 50 V | ±10% |
| C22 | 110166 | CAP | TANTA | 2 2 µF | 20 V | ±20% |
| CR1 | 210058 | DIODE | 1N458 | | | |
| CR2 | 210056 | DIODE | MODIFIED | 018 | | |
| CR4 | 210054 | DIODE | RECTIFIER | 3 A | 50 V | |
| CR5 | 210054 | DIODE | RECTIFIER | 3 A | 50 V | |
| CR6 | 210054 | DIODE | RECTIFIER | 3 A | 50 V | |
| CR7 | 210054 | DIODE | RECTIFIER | 3 A | 50 V | |
| CR8 | 210056 | DIODE | MODIFIED | 018 | | |
| CR9 | 210056 | DIODE | MODIFIED | 018 | | |
| CR10 | 210058 | DIODE | 1N458 | | | |
| VR1 | 220071 | DIODE | ZENER | 1N5850 | 6.2 V | ±10% |
| VR2 | 220076 | DIODE | REF ZENER | | | |
| J1 P1 | 453895 | CONNECTOR-LIQUID XTAL | | | | |
| LCD1 | 920663 | LIQUID XTAL DISPLAY | | | | |

## Table 4.3 - Parts List (continued)

| REF DESIG | P/N | DESCRIPTION | | | |
|---|---|---|---|---|---|
| R1 | 010855 | RES | CARBON FILM | 1 M | ± 2% 1 W |
| R2 | 010844 | RES | CARBON FILM | 1 M | ± 5% 1/2W |
| R3 | 040292 | POT | CERMET | 5 M | ±30% |
| R4 | 001876 | RES | CARBON COMP | 51 M | ± 5% 1/4W |
| R5 | 040295 | POT | CERMET | 250 K | ±20% |
| R6 | 010852 | RES | CARBON FILM | 390 K | ± 2% 1/4W |
| R7 | 010947 | RES | METAL FILM | 909 K | ± 1% 1/10W |
| R8 | 010838 | RES | CARBON FILM | 100 K | ± 2% 1 W |
| R9 | 010843 | RES | CARBON FILM | 1 M | ± 2% 1/4W |
| R10 | 001886 | RES | CARBON COMP | 100 M | ± 3% 1/4W |
| R11 | 010887 | RES | METAL FILM | 1.18 M | ± 1% 1/8W |
| R12 | 001871 | RES | CARBON COMP | 1.6 M | ± 5% 1/4W |
| R13 | 010839 | RES | CARBON FILM | 150 K | ± 2% 1/4W |
| R14 | 040293 | POT | CERMET | 5 K | ±20% |
| R15 | 010883 | RES | METAL FILM | 17.4 K | ± 1% 1/10W |
| R16 | 010853 | RES | CARBON FILM | 750 K | ± 2% 1/4W |
| R18 | 020665 | RES | WIREWOUND | 9.9 K | ± 1% 3 W |

## Table 4.3 - Parts List (continued)

| REF DESIG | P/N | DESCRIPTION | | | |
|---|---|---|---|---|---|
| R19 | 010832 | RES | METAL FILM | 99 OHM | ± 1% 1/10W |
| R20 | 020666 | RES | WIREWOUND | .9 OHM | ± 1% 3 W |
| R21 | 020664 | RES | WIREWOUND | .1 OHM | ± 1% 3 W |
| R23 | 010835 | RES | CARBON FILM | 24 K | ± 2% 1/4W |
| R24 | 010885 | RES | METAL FILM | 88.7 K | ± 1% 1/10W |
| R25 | 010835 | RES | CARBON FILM | 24 K | ± 2% 1/4W |
| R26 | 010835 | RES | CARBON FILM | 24 K | ± 2% 1/4W |
| R27 | 010851 | RES | CARBON FILM | 43 K | ± 2% 1/4W |
| R28 | 010893 | RES | CARBON COMP | 100 K | ± 2% 1/4W |
| R30 | 040292 | POT | CERMET | 5 M | ±30% |
| R31 | 001817 | RES | CARBON COMP | 10 M | ± 5% 1/4W |
| R32 | 001871 | RES | CARBON COMP | 1.6 M | ± 5% 1/4W |
| R33 | 040291 | POT | CERMET | 1 M | ±20% |
| R34 | 010884 | RES | METAL FILM | 55.6 K | ± .5% 1/10W |
| R35 | 040288 | POT | CERMET | 10 K | ±20% |
| R36 | 010835 | RES | CARBON FILM | 24 K | ± 2% 1/4W |
| R37 | 001820 | RES | CARBON COMP | 30 M | ± 5% 1/4W |

## Table 4.3 - Parts List (continued)

| REF DESIG | P/N | DESCRIPTION |
|---|---|---|
| R38 | 001819 | RES CARBON COMP 100 M ± 5% 1/4W |
| R39 | 010915 | RES CARBON FILM 200 OHM ± 2% 1/4W |
| R40 | 010834 | RES CARBON FILM 1 K ± 2% 1/4W |
| R41 | 010852 | RES CARBON FILM 390 K ± 2% 1/4W |
| R42 | 010853 | RES CARBON FILM 750 K ± 2% 1/4W |
| U1 | 010846 | RES MODULE, ANALOG |
| U2 | 010847 | RES MODULE, DIGITAL |
| U3 | 010848 | RES MODULE, ATTENUATOR |
| U4 | 230188 | ANALOG 5007R |
| U5 | 230179 | CMOS DIGITAL 7104A |
| W1 | 500022 | BUSS WIRE 22 GA |

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